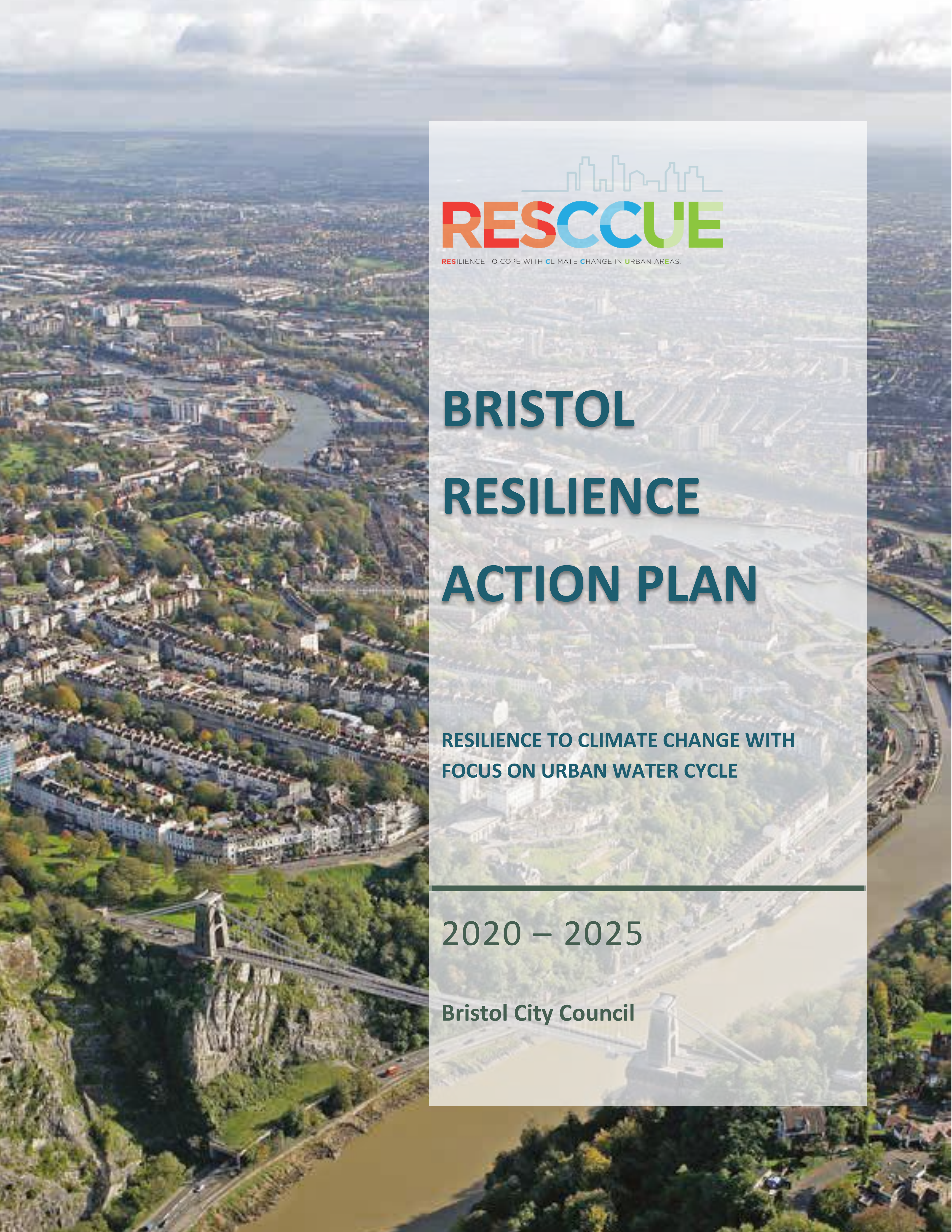

RESCCUE

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

BRISTOL RESILIENCE ACTION PLAN

RESILIENCE TO CLIMATE CHANGE WITH FOCUS ON URBAN WATER CYCLE

2020 – 2025

Bristol City Council

BRISTOL RESILIENCE ACTION PLAN

Bristol City Council

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DATE	VERSION
29/08/2019	1.0 - Proposal of RAP 1st part
17/10/2019	2.0 - Revision and update of RAP 1st part
5/12/2019	3.0 - Addition of proposal of RAP 2nd part
08/01/2020	4.0 - Revision and update of RAP 2nd part
28/04/2020	5.0 - Revision and update of pre-final complete version
28/07/2020	6.0 - Complete version for revision
11/09/2020	Revised version

This plan is based on a template provided by RESCCUE Project (H2020 RESCCUE - RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water, Grant Agreement no.700174): **www.resccue.eu**

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Disclaimer

This RAP was developed within the RESCCUE project, solely by the authors and contributors and it has not (at the time of writing) followed an official approval process within Bristol City Council. Therefore, whilst the findings from the RAP process will feed into the Council's ongoing resilience plans, the specific action cannot at this time be considered as Council policy.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
ASA	Association of SuDS Authorities
BCC	Bristol City Council
CBA	Cost-Benefit Analysis
CC	Climate change
CEA	Cost-effectiveness analysis
CSO	Combined Sewer Overflow
GDP	Gross Domestic Product
GIS	Geographic Information System
ICLEI	Local Governments for Sustainability global network
Infoworks ICM	InfoWorks Integrated Catchment Modelling
M x	Measure reference number x
MAOD	Metres Above Ordnance Datum
MCA	Multi-Criteria Analysis
MVA	Megavolt amperes
NBS	Nature Based Solutions
RAF App	Resilience Assessment Framework web-based tool
RAF	Resilience Assessment Framework
RAP	Resilience Action Plan
RCP	Representative Concentration Pathway
RESCCUE	RESilience to cope with Climate Change in Urban arEas
SO	Strategies that use the strengths to exploit opportunities
ST	Strategies that exploit strengths to overcome any potential threats
SUDS	Sustainable Drainage Systems
SUMO	Simulation of Urban Mobility
SWOT	SWOT analysis (or SWOT matrix) to identify strengths (S), weaknesses (W), opportunities (O), and threats (T)

TOWS	TOWS analysis to link the different components of a SWOT together to come out with clear actions (SO, WO, ST, WT)
Tx	Return period of x years
UK	United Kingdom
UNISDR	Presently UNDRR, United Nations Office for Disaster Risk Reduction
WO	Strategies that mitigate weaknesses, by exploiting opportunities
WT	Strategies attempting to minimise weaknesses to avoid the impact of threats

EXECUTIVE SUMMARY

Bristol developed this resilience action plan (RAP) for the Bristol City Council administrative area and metropolitan area. The present planning has a medium-term horizon of five years, from 2020 to 2025, in articulation with the strategic planning horizons for Bristol.

The objective of this plan is to provide a roadmap to improve the resilience to climate change with focus on water.

The Bristol vision is to be a flourishing, welcoming and sustainable city. Bristol aims to have safe and affordable neighbourhoods, with a high quality of life, sustainable economic and housing growth and an accessible transport system that meets the city needs. Bristol intends to be a city with low carbon emissions addressing the challenges of climate change, with infrastructures and services flexibly designed and managed to cope with uncertainty.

The objectives considered to assess resilience to climate change, including the urban services and their infrastructure, are to achieve:

- City collective engagement, awareness of citizens and communities, leadership and management, preparedness for basic conditions, climate change, disaster response and recovery and build back for the organisational dimension of the city;
- Spatial risk management and provision of protective infrastructure and ecosystems for the spatial dimension of the city;
- Services planning and risk management, autonomy and preparedness for climate change, disaster response and recovery and build back for the functional dimension of the city;
- Safe, autonomous, flexible as well as prepared infrastructures for the physical dimension of the city.

The plan considers the interactions and contributions to city's resilience of the following strategic urban services: water supply, wastewater drainage and treatment, storm water drainage, waste collection and treatment, electric energy supply and mobility.

The most critical climate-related hazard for Bristol is flooding. Consideration of future climate scenarios were therefore undertaken in respect of sea level rise, heightened river flows and extreme precipitation for pluvial, fluvial and tidal river flooding.

The main concerns for the incoming years are flooding and combined sewer overflow, but also drought, heat waves, wind storms, due to temperature, precipitation or wind extreme events occurrence, that have always represented a threat to Bristol's resilience which are expected to be aggravated by climate change (Pagani et al., 2018). Bristol intends to achieve the above-mentioned resilience objectives, particularly reducing the risk regarding these hazards, preparing the population and the services for their occurrence and promoting a better articulation between urban services.

The planned strategies expected to have greater impact on the city are to develop community flood plans, to keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis, to build riverside flood defence walls and to reduce surface water runoff and sewer overload by adding raingardens before sewer inlets. With this planned set of strategies, Bristol aims to achieve a significant part of its long-term resilience objectives regarding climate change, with focus on the urban water cycle.

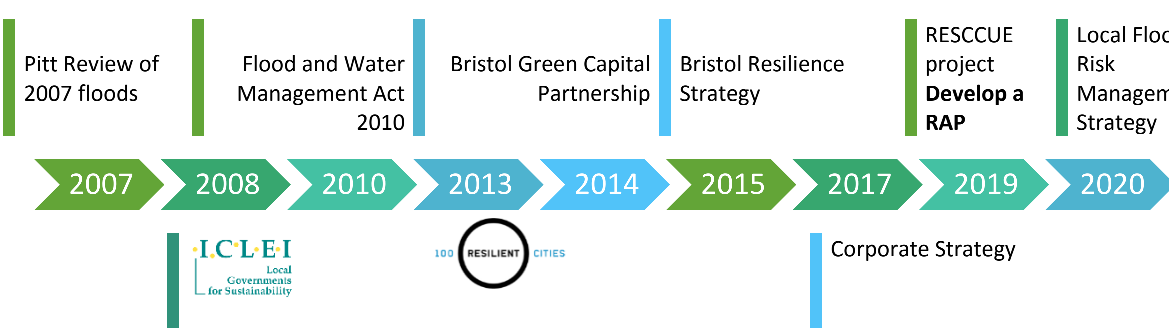
1. INTRODUCTION

BACKGROUND

Located in the south-west England, predominantly on a limestone area, Bristol is one of the most densely populated parts of the UK and, after London, the second largest city in the southern region. Most of the urban extent of Bristol is based around the watercourses and river network, with two major rivers flowing through the city (Avon and Frome rivers) resulting in a characteristically hilly landscape. It is one of the warmest cities in the UK and there is a relatively even distribution of rainfall throughout the year, although the autumn and winter seasons tend to be the wettest. Bristol's urban environment encompasses a medieval city centre and a historic dockland, high density housing located in the inner city, large-scale industry strategically situated near the docklands, and the suburban quarters remain mostly residential with vast amounts of green space. Within this context, Bristol has been investing in plans to create and improve resilient systems to tackle its various urban challenges. Based on the analyses conducted by local and international actors working on resilience, the main urban challenges in Bristol can be profiled firstly in terms of natural and environmental hazards and secondly with regards to broader socio-economic issues, all of which are exacerbated when coupled with climate change effects and unplanned urbanisation (Pagani et al., 2018). The resilience of the city to climate change can be highly related to its urban services' resilience, their interdependencies and cascade effects.

The Bristol vision is to be a flourishing, welcoming and sustainable city. Bristol aims to have safe and affordable neighbourhoods, with a high quality of life, sustainable economic and housing growth and an accessible transport system that meets the city needs. Bristol intends to be a city with low carbon emissions addressing the challenges of climate change, with infrastructures and services flexibly designed and managed to cope with uncertainty.

Bristol City Council has already developed an intensive work towards resilience and it is proactively committed to increase Bristol's resilience: from social cohesion to economic stresses and by enhancing resilience to all sources of flooding. An example is the implemented Ashton strategy of identification of high-risk areas by conducting studies involving flood-modelling analysis. Bristol's commitment to resilience is evident in The Bristol Resilience strategy. The Bristol Green Capital Partnership established in 2014, proceeding with diverse initiatives, with the city work in Core City UK and ICLEI, with 100 Resilient Cities, as well as the 2019 One City Plan amongst others (Pagani et al., 2018).



The urban water cycle is the scope for this plan, due to the importance of water-related risks in the functioning of the city. This resilience action plan (RAP) is a thematic plan that contributes to the city's global planning and relates to other planning instruments in Bristol such as:

- City Master Plan;
- 100 Resilient cities (Rockefeller Foundation);
- Emergency and contingency city plans;
- Local Flood Risk Management Strategy (2018).

ABOUT THE PLAN

Plan scope, focus and time horizon

Bristol developed this resilience action plan (RAP) for the Bristol City Council (BCC) administrative area. The present planning has a medium-term horizon of 5 years, from 2020 to 2025. The scope of this plan is resilience to climate change (CC) with focus on the urban water cycle.

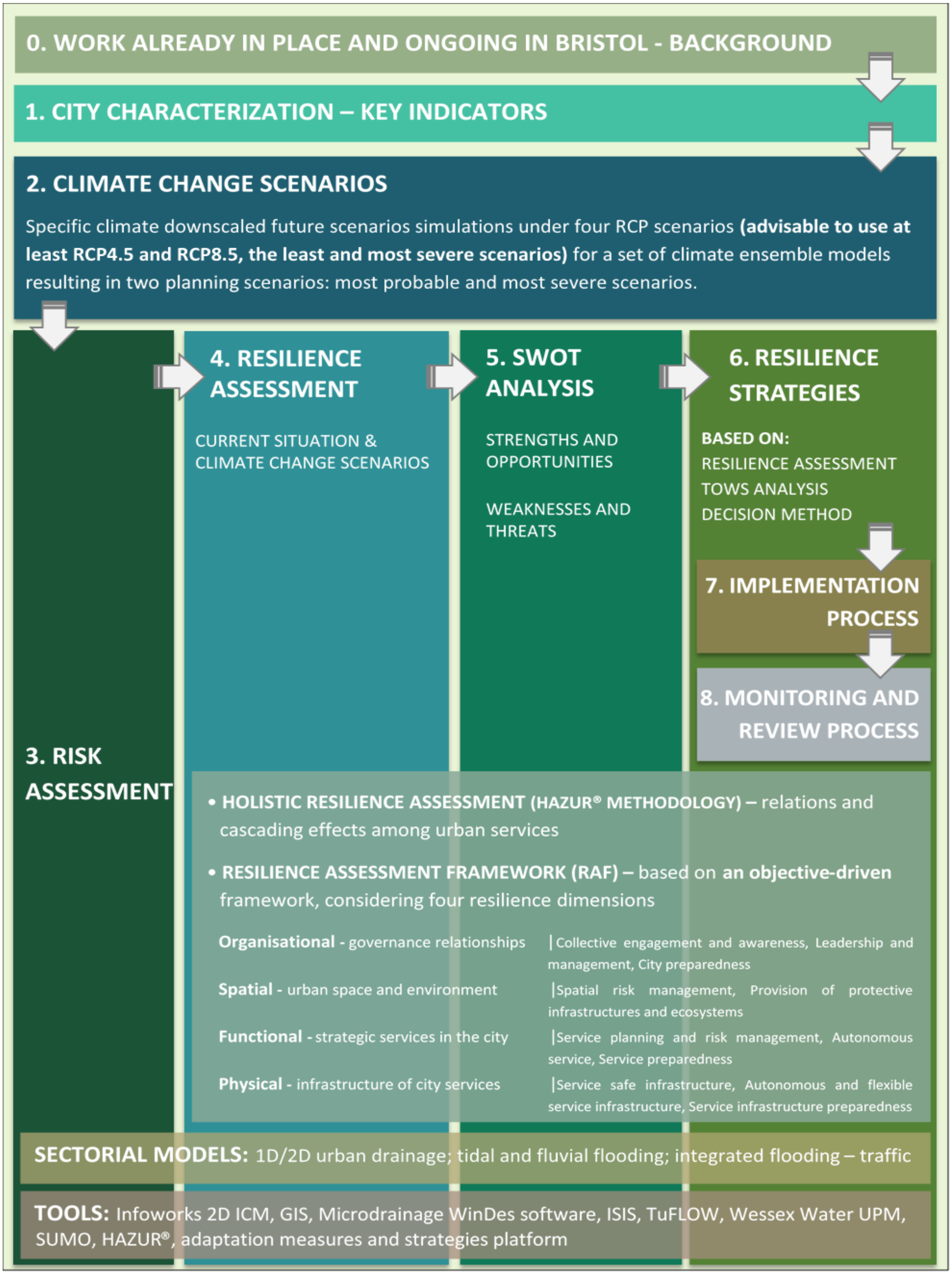
Geographical scope of the plan

Addressed urban services

There is consideration of the following urban services, their interactions and contributions to city's resilience in the plan: water supply, wastewater drainage and treatment, storm water drainage, waste collection and treatment, electric energy supply and mobility. These services are within the scope of this plan as they relate with the water cycle, either providing a water service, being affected by these services' performance or affecting their performance.

In the resilience assessment, the services consider the BCC administrative area.

Planning process



Document structure

This document provides a five years’ roadmap for resilience, defining a path to enhance resilience of the city and its services regarding climate change, with focus on the urban water cycle. It is based on the intense work and background already existing in Bristol, the establishment of climate change planning scenarios, the characterisation of the city context and hazards, the risk and resilience assessment and on the development of the strategies that need to be implemented to enhance the resilience of the city to climate change with focus on water. It was supported on the RESCCUE's template, guidelines and results obtained using tools and approaches developed in this project (www.resccue.eu).

The plan is structured in 7 sections. This first introductory section provides the city background, an overview of the plan scope, focus, time horizon, planning process and structure.

In section 2, a brief characterization of the city and addressed urban services is provided, focusing on the plan scope.

In section 3, the climate change scenarios considered for the city in this plan are briefly presented, as well as the related hazards, risk and vulnerabilities.

The resilience assessment and a SWOT analysis are presented in section 4, followed by the description and planning of the adaptation strategies selected, in section 5.

In section 6, steps for plan monitoring and review are acknowledged and scheduled.

Section 7 presents the final remarks of the plan, with a brief list of identified benefits and future challenges, as well as any relevant acknowledgments.

Detailed or confidential information regarding the assessment or description of the strategies are included as confidential annexes.

2. CITY CHARACTERIZATION

CITY PROFILE

Bristol is located in the south west of England and is the eighth most populous city in the country and one of the warmest in the United Kingdom. Throughout the year, rainfall is relatively evenly spread, although the autumn and winter seasons tend to be the wettest; extreme heat waves and extreme cold spells do not occur regularly.

Economically, Bristol developed strong advancements in the manufacturing and aerospace sector, continuing to have the fastest growing economy of any British city outside of London. The main urban challenges in Bristol can be profiled firstly in terms of natural and environmental hazards and secondly with regards to broader socio-economic issues, all of which are exacerbated when coupled with climate change effects and unplanned urbanisation (Pagani et al., 2018). The city characterization focuses on the scope of this plan.

BRISTOL

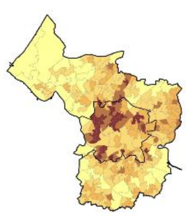
GEOGRAPHICAL CHARACTERISTICS

Country: England

Altitude: 4.05-113.00 m

Metropolitan area: 1 000 km^2

Urban area: 110 km^2



- Tidally influenced rivers
- Varied topography

CLIMATE

Climate type: Marine West Coast Climate (Köppen climate classification)

Average temperature:

annual	hottest month	coldest month
10.5°C	18.0°C	6.0°C

Average rainfall:

annual	wettest month	driest month
800-900 mm	94.0 mm	50.8 mm

Sea level – Max tidal amplitude: 14 m (tidal range)

Local mean (Cumberland Basin 2015): 7.5 m

Cold wave average annual duration: 5 days

POPULATION

Urban population density: 3 910 inhabitants/km^2

Urban permanent population: 449 300 inhabitants

Urban population – commuters: 80 982

Population of the metropolitan area: 724 000 inhabitants

ECONOMY & GOVERNANCE

GDP: 92 560 000 €

GINI index: 0.40

Political cycle: 4 years

BUILT AND NATURAL ENVIRONMENT & INFRASTRUCTURE

Services in the city: Water, wastewater, storm water, waste, energy, mobility (road, train, air)

Protected areas in the city: Ecological or sensitive, cultural or historical heritage

Ecosystem services: SuDS, highway bio-retention pods, attenuation basins, green roofs, tree planting, green spaces and sewage treatment plant

EXISTING CLIMATE-RELATED HAZARDS IN THE CITY

Flooding - rainfall and sea level
Drought
Heat wave
Wind storm
Combined sewer overflow (CSO)

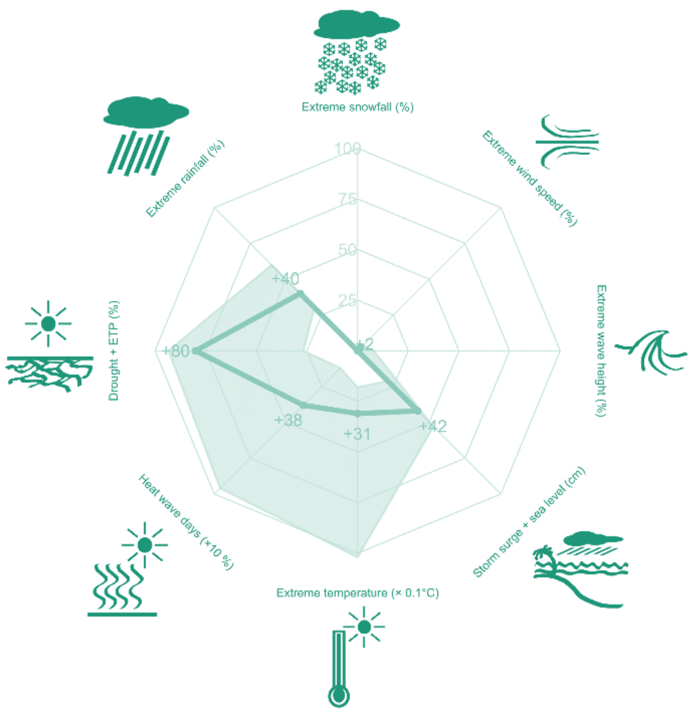
HISTORICAL RELEVANT EVENTS AND TIME SCOPE OF ANALYSIS

Looking at historical relevant events, Bristol has suffered from significant flooding in the past.

- The flood of 1968 was one of the most damaging in Bristol's recent history, caused by both surface water and fluvial flooding that resulted in high damages and impacts to the city and its inhabitants. The construction of large interceptor tunnels in response to this, to divert exceedance flows higher up in the catchment, reduced fluvial flood risk in the city (Pagani et al., 2018).
- 2012 saw significant flooding occurred across most of the UK due to some of the highest rainfall events since record collection began. During this time, the most notable single flood event lasted two days (November 21-22, 2012), with 30 houses internally flooded and many more suffering flooding of gardens, garages and driveways (Pagani et al., 2018).

Looking at historical data records used in the RAP analysis, they refer to the last 100 years.

EXTREMES COMPASS ROSE FOR BRISTOL



Marking the maximum change in climate extreme events throughout the century (return periods between 2 and 100 years) (Monjo et al., 2018).

The edge corresponds to an increase of 100%. For heat wave days (border is +1000%) for extreme temperature (border is +10°C).

Note that this RAP focuses the flooding hazard in Bristol. Consequently, it considers only the flooding related variables that affect the city and services.

PLAYERS AND STAKEHOLDERS

Given this resilience plan thematic scope and focus (climate change and urban water cycle), Bristol identified all the players and stakeholders involved in this resilience process. Several players from very different areas - both public and private - participate in the management of the services and infrastructures, and several stakeholders are involved in strengthening Bristol's resilience-building efforts (Canalias et al., 2017).

Group name	Players
Strategic group	**Bristol City Council, Wessex Water, Environment Agency**
Steering group	**Bristol City Council, Wessex Water, Environment Agency**
Action group	**Bristol City Council** (community, flood management, civil contingency, mobility – city roads and general transport)
	Bristol Water (water supply service)
	Wessex Water (urban drainage and wastewater treatment)
	Environment Agency (flood management)
	Western Power (electrical energy supply)
	National Grid (power transmission)
	First Bus (mobility – bus services)
	Bristol Waste Company (waste collection)
	Highways England (motorways)
	Network Rail (railway network)
	Lower Severn Internal Drainage Board (Avonmouth rhine network)
	British Telecomm (telecommunications)

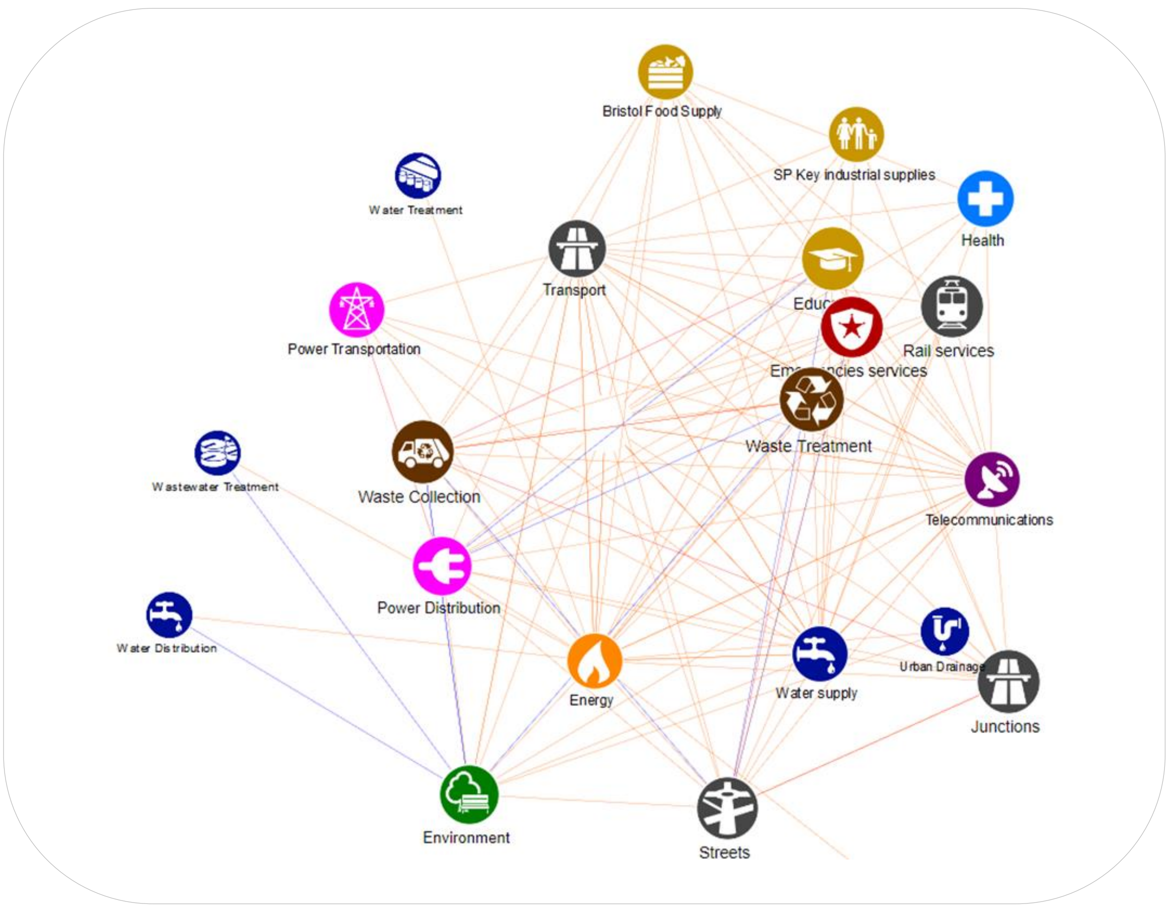
Stakeholders

Met office (weather services)
Wales & West Utility (gas distribution)
SSE (electricity and telecommunications)
EE (telecommunications)
Openreach (telecommunications)

SERVICE PROFILE

Urban services play a very relevant role in city resilience. The services considered in this plan interact and face their own specific challenges due to climate change. Their resilience contributes to Bristol's resilience.

INTERDEPENDENCIES ANALYSIS FOR BRISTOL



ASSESSED SERVICES

SERVICES CONTEXT CHARACTERIZATION

	Water	Wastewater	Storm water	Waste	Energy	Mobility
Utilities No.	1	1	1	1	2	4
Inhabitants covered	1.2 million	671 000	671 000	459 500	459 500	1.0 million
Area covered (km^2)	2 589.988	241	241	110	110	1 000
Relevant info.	-	31 400 000 kWh of energy consumption 14 400 000 kgCO_2e emissions	31 400 000 kWh of energy consumption 14 400 000 kgCO_2e emissions	-	-	1 783 GWh of energy consumption 432 960 ton CO2 emissions (transport sector)
Scope of analysis	Bristol city and surrounds	Greater Bristol urban extent	Greater Bristol urban extent	BCC area	BCC area	Bristol commuter catchment

SERVICE INFRASTRUCTURE

WATER

Total length of conduits (km)	6 700
Water abstractions (No.)	-
Pumping stations (No.)	164
Treatment plants (No.)	16
Storage tanks (No.)	139

WASTEWATER

Total length of sewers (km)	11 990
Pumping stations (No.)	19
Treatment plants (No.)	1
Combined sewer overflows (No.)	278
Marine outfall (No.)	1

STORMWATER

Total length of sewers (km)	10 945
Pumping stations (No.)	29
Treatment plants (No.)	0
SUDS (No.)	11
Rainwater sewer overflows (No.)	278
Detention tanks (No.)	-

WASTE

Waste containers (No.)	200 000
Waste collection vehicles (No.)	180
Recycling centres (No.)	1
Transfer stations (No.)	2
Composting plants (No.)	1
Incinerators (No.)	1
Sanitary landfills (No.)	10

ENERGY

Total length of aerial network (km)	Unavailable
Total length of subterranean network (km)	Unavailable
Power stations (No.)	1
Installed power (MVA)	Unavailable

MOBILITY

Total length of road network (km)	1162
Total length of cycling network (km)	610
Total length of train network (km)	42
Airports (No.)	1
Airport passengers (No.)	8 700 000

EXISTING HAZARDS IN THE SERVICES

Water	Wastewater	Storm water	Waste	Energy	Mobility
Flooding - Rainfall	**Flooding -** Rainfall	**Flooding -** Rainfall	**Flooding -** Rainfall	**Flooding –** Rainfall	**Flooding -** Rainfall
Flooding – Sea level	**Flooding –** Sea level	**Flooding –** Sea level	**Flooding –** Sea level	**Flooding –** Sea level	**Cold wave -** Temperature
Cold wave - Snowfall	**Cold wave -** Snowfall	**Cold wave -** Snowfall	**Cold wave -** Snowfall	**Cold wave -** Snowfall	**Cold wave -** Snowfall
Heat wave	**Heat wave**	**Heat wave**	**Heat wave**	**Heat wave**	**Heat wave**
Drought	**Drought**	**Drought**	**Drought**	**Drought**	**Drought**
Wind storm	**Wind storm**	**Wind storm**	**Wind storm**	**Wind storm**	**Wind storm**
Combined sewer overflow	**Combined sewer overflow**	**Combined sewer overflow**	**Combined sewer overflow**		**Combined sewer overflow**

3. CLIMATE CHANGE SCENARIOS AND RISK ASSESSMENT

HAZARDS SOURCES AND PLANNING SCENARIOS

Several hazards may affect the city, services and infrastructures. In Bristol, this RAP focuses on the flooding from intense precipitation and from sea level rise for the assessment of the city and the water related services, waste and energy services. The mobility service considers flooding from intense precipitation. For these hazards and related variables, climate change scenarios in line with UK national guidance for assessment are agreed (Monjo et al., 2018).

A planning scenario corresponds to a hazard condition, described by the characterization of its trigger variables by experts, for comprehensive assessment of the severity, probability of occurrence and its total impact. As a minimum, cities would ideally define two planning scenarios. The Most Probable relates to a hazardous event that causes disruption, assessed by experts to be the most likely to occur. The Most Severe relates to a hazardous event that causes greater disruption, assessed by experts to be the worst case to plan for (based on UNISDR, 2015).

CLIMATE CHANGE SCENARIOS FOR THE CITY AND SERVICES

CITY

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO	1-5 years return period Aggravation of 40 % to account for CC 10-20 mm RCP 8.5 for 2115
MOST SEVERE SCENARIO	100 years return period Aggravation of 40 % to account for CC 200 mm in 3 hours RCP 8.5 for 2115

CITY

FLOODING – SEA LEVEL RISE

MOST PROBABLE SCENARIO	Tide level = 8.5 mAOD (Metres Above Ordnance Datum) Aggravation of 1.0 m rise to account for CC RCP 4.5 for 2120
MOST SEVERE SCENARIO	Tide level = 9.4 mAOD (Metres Above Ordnance Datum) 0.5% AEP (Annual Exceedance Probability) Aggravation of 1.0 m rise to account for CC RCP 4.5 for 2120

WATER

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO

5 years return period
Aggravation of 40% to account for CC
>30 mm
RCP 8.5 for 2115

MOST SEVERE SCENARIO

30 years return period
Aggravation of 40 % to account for CC
>50 mm
RCP 8.5 for 2115

WATER

FLOODING – SEA LEVEL RISE

MOST PROBABLE SCENARIO

Tide level = >8.0 mAOD
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

MOST SEVERE SCENARIO

Tide level = >9.0 mAOD
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

WASTEWATER AND STORMWATER

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO

5 years return period
Aggravation of 40% to account for CC
>30 mm
RCP 8.5 for 2115

MOST SEVERE SCENARIO

30 years return period
Aggravation of 40 % to account for CC
>50 mm
RCP 8.5 for 2115

WASTEWATER AND STORMWATER

FLOODING – SEA LEVEL RISE

MOST PROBABLE SCENARIO

Tide level = >8.0 mAOD
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

MOST SEVERE SCENARIO

Tide level = >9.0 mAOD
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

WASTE

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO

5 years return period
Aggravation of 40% to account for CC
>30 mm
RCP 8.5 for 2115

MOST SEVERE SCENARIO

30 years return period
Aggravation of 40 % to account for CC
>50 mm
RCP 8.5 for 2115

WASTE

FLOODING – SEA LEVEL RISE

MOST PROBABLE SCENARIO

Tide level = 9.0 mAOD (Metres Above Ordnance Datum)
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

MOST SEVERE SCENARIO

Tide level = 9.4 mAOD (Metres Above Ordnance Datum)
0.5% AEP (Annual Exceedance Probability)
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

ENERGY

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO

30 years return period
Aggravation of 40% to account for CC
RCP 8.5 for 2115

MOST SEVERE SCENARIO

100 years return period
Aggravation of 40 % to account for CC
>100 mm
RCP 8.5 for 2115

ENERGY

FLOODING – SEA LEVEL RISE

MOST PROBABLE SCENARIO

Tide level = 9.0 mAOD (Metres Above Ordnance Datum)
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

MOST SEVERE SCENARIO

Tide level = 9.4 mAOD (Metres Above Ordnance Datum)
0.5% AEP (Annual Exceedance Probability
Aggravation of 1.0 m rise to account for CC
RCP 4.5 for 2120

MOBILITY

FLOODING – INTENSE PRECIPITATION

MOST PROBABLE SCENARIO	10 years return period Aggravation of 40 % to account for CC RCP 8.5 for 2115
MOST SEVERE SCENARIO	100 years return period Aggravation of 40 % to account for CC RCP 8.5 for 2115

BRISTOL CAN EXPECT MORE CLIMATE-RELATED EVENTS IN THE FUTURE. IN THIS PLAN:

Flooding

Flooding from **intense precipitation** can cause damage to people, buildings and other facilities as well as infrastructures; affect mobility and disrupt transport services; overwhelm stormwater drainage systems and affect wastewater treatment; and may cause other damages and collapses resulting in interruption of energy supply, affecting all other services and infrastructures' components.

Flooding

Flooding from **sea level rise** can cause damage to people, buildings and other facilities as well as infrastructures; affect mobility and disrupt transport services (less travels and more delays) and affect wastewater treatment.

Cold wave

Coldwaves from **snowfall** can affect the transport service (traffic), cause damages and collapses in buildings and other facilities as well as infrastructures, such as the energy infrastructure, resulting in interruption of energy supply, affecting all other services.

Wind storm

Wind storm from **intense wind** can cause temporary disruption to waste and energy services and infrastructures, that may result in waste containers displacement and in interruptions of energy supply, affecting all other services.

RISK ASSESSMENT

SECTORIAL MODELS IN THE CITY

The sectorial models used in Bristol were based on historical data and on projections of future climate scenarios. They provide a thorough characterization of the urban services, their relations with climate variables, as well as detailed analysis of interdependencies and elaboration of hazard maps.

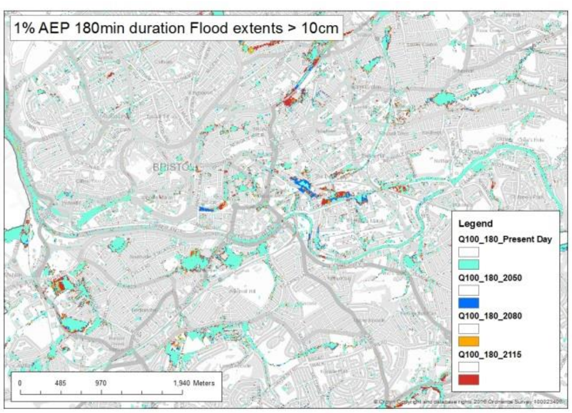
Mathematical modelling was developed using Infoworks 2D ICM, GIS, Microdrainage WinDes Software, ISIS, TuFLOW and Wessex Water UPM to the whole Bristol administrative area, to the water, wastewater and storm water services. For the mobility service, SUMO and GIS was used (Russo et al., 2019).

For different scenarios, considering both the current situation and the future with climate change, flooding exposure and vulnerability of each urban service were characterised and the respective hazard maps were produced (Russo et al., 2019) and may be visualised in https://csis.myclimateservice.eu/studies.

The effects of multiple hazards in the city were also studied, namely tidal and fluvial flooding and integrated flooding-traffic and flooding-electrical relations (Evans et al., 2019).

MOST PROBABLE SCENARIO

Exposure map for flooding – rainfall induced scenario 2019-2115

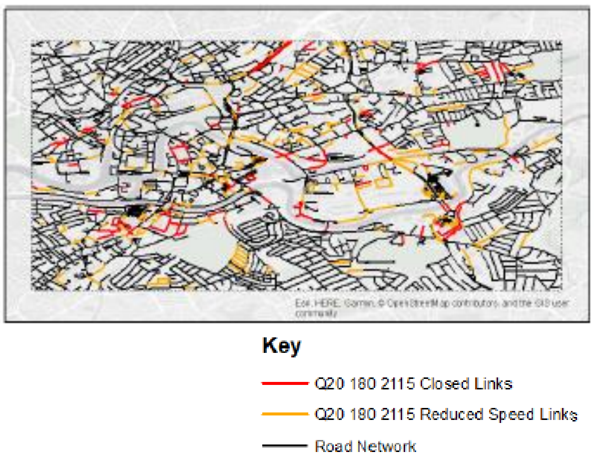


Exposure map for flooding – tidal induced scenario 2079-2115

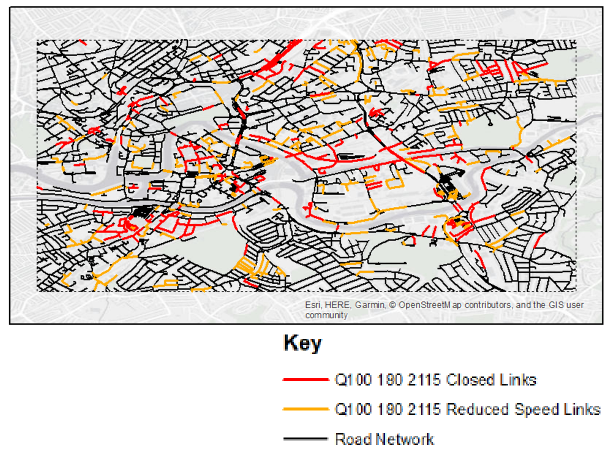
RISK-RELATED MAPS FOR MOBILITY SERVICE

CLIMATE CHANGE SCENARIOS

Risk map for rainfall induced flooding – Most probable for 2115 (return period of 20 years)



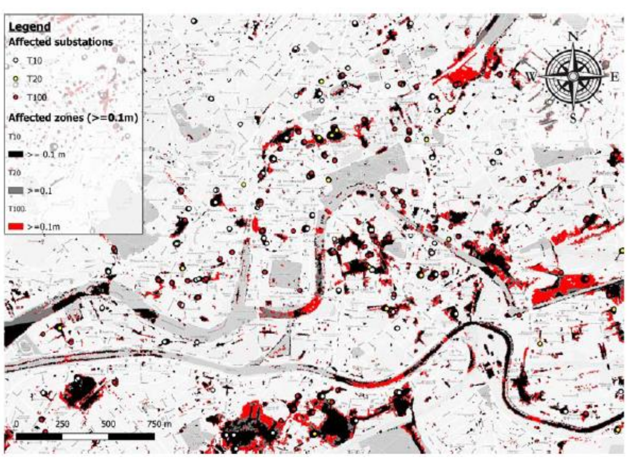
Risk map for rainfall induced flooding – Most severe for 2115 (return period of 100 years)



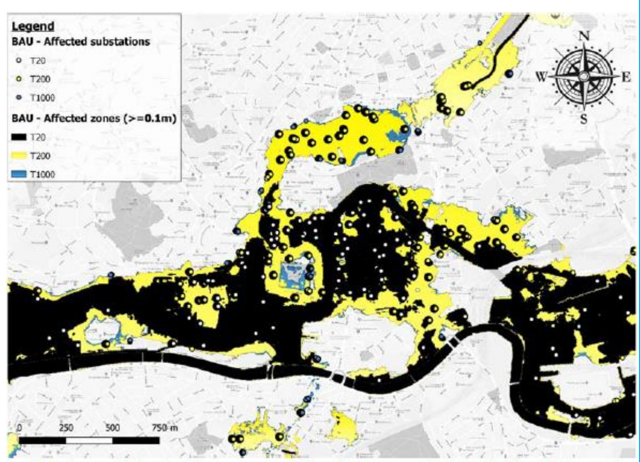
RISK-RELATED MAPS FOR ENERGY SERVICE

CLIMATE CHANGE SCENARIOS

Exposure map for rainfall induced flooding – Most probable and most severe (return period of 20 and 100 years, respectively)



Exposure map for tidal induced flooding – Most probable and most severe (return period of 200 and 1000 years, respectively)



4. RESILIENCE ASSESSMENT AND SWOT ANALYSIS

RESILIENCE ASSESSMENT

Resilience assessment enables to highlight where Bristol and the urban services stand today (reference situation), regarding resilience to climate change, and to identify the most critical aspects to be improved, taking into account both the reference situation and the expected impacts of climate change scenarios. The integration of the resilience assessment results provided by all sources of analysis is presented in the SWOT analysis. This supports the identification of resilience measures and strategies for this RAP to implement in the city and services.

HOLISTIC APPROACH ASSESSMENT IN THE CITY

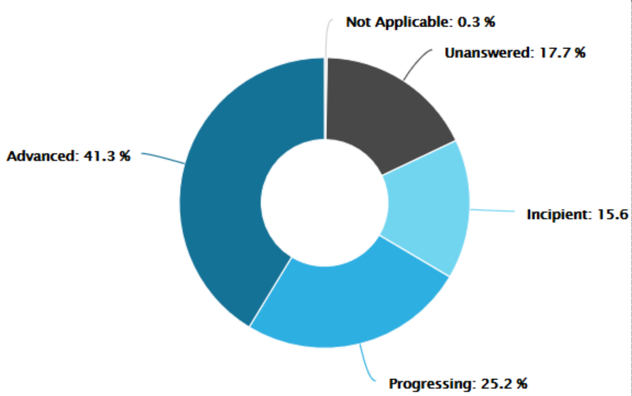
The HAZUR® methodology and tool conducted the holistic approach implemented in the resilience assessment. It analyses the cascading effects that have collateral impacts on other strategic urban services and the city. The identification of players, the description of the water related services and infrastructure, the dependencies, the hazards and impacts on recovery time were all analysed (Canalias et al., 2017). This was a result of collaborative workshops and a collection of historical data and data from the sectorial models.

BRISTOL OVERALL ASSESSMENT– RESILIENCE ASSESSMENT FRAMEWORK

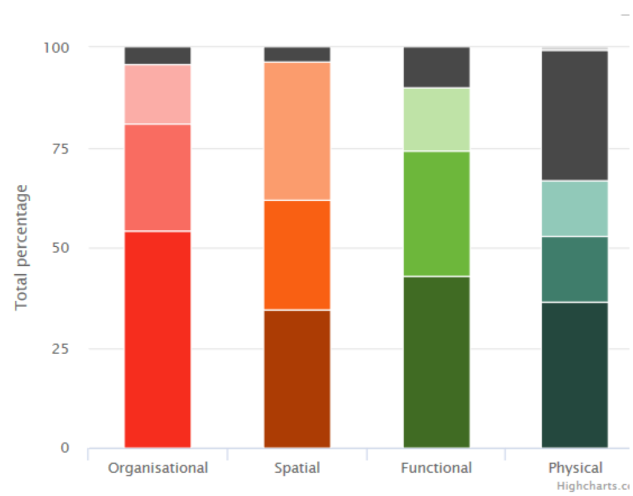
An overall resilience to climate change was assessed based on an objective-driven framework, considering four resilience dimensions for CC, with focus on urban water cycle: organisational, spatial, functional and physical. The resilience assessment framework (RAF) applied to Bristol, including the services, was the RESCCUE RAF (Cardoso et al., 2018; Cardoso et al., 2020a) supported by the RAF App tool (Cardoso et al., 2020b). These provide the percentage of assessment metrics assigned to a resilience development level – incipient, progressing or developed (represented respectively from a lighter to a darker colour in the figures) – as well as those without information, that were not answered, and the ones not applicable to the city. The following results illustrate the overall assessment for pluvial flooding. Similar results were obtained for tidal river flood.

In Bristol, overall resilience development in the city is advanced in nearly half of the aspects assessed. Around a quarter shows as progressing and the remainder incipient, unanswerable or not applicable. Organisational resilience is overall the most advanced resilience dimension, followed by the functional dimension. The physical dimension presents the highest percentage of metrics that were not answered, followed by the functional dimension, what may be due to data that is not easily applicable to the metrics provided in the RAF, in some cases, and to lack of information in other cases.

OVERALL RESILIENCE DEVELOPMENT LEVEL IN THE CITY



RESILIENCE DEVELOPMENT IN EACH DIMENSION



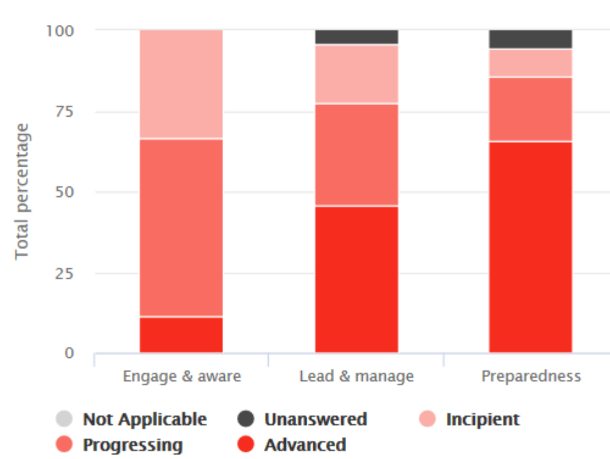
RAF ASSESSMENT FOR THE ORGANISATIONAL AND SPATIAL RESILIENCE DIMENSIONS

Organisational dimension focuses on city level, analysing governance structures, the stakeholder's involvement and the city's resilience engagement and preparedness for climate change.

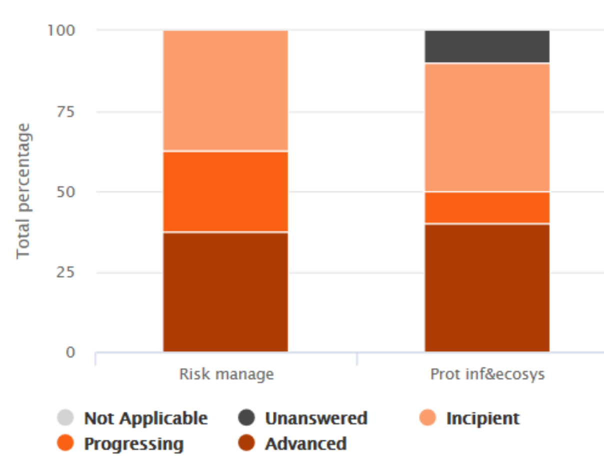
Spatial dimension also focuses on city level, analysing herein the urban space, protective infrastructures and ecosystems.

DETAILED DEVELOPMENT LEVEL FOR THE CITY

ORGANISATIONAL



SPATIAL



In the Organisational dimension, the overall resilience development level of the City Preparedness objective is significantly advanced, followed by the Leadership and Management objective, where it is also evident a relevant progressing development. The Collective Engagement and Awareness objective is the one presenting a lower advanced level while the progressing development level is the most expressive. Overall, this dimension still presents some opportunities for improvement.

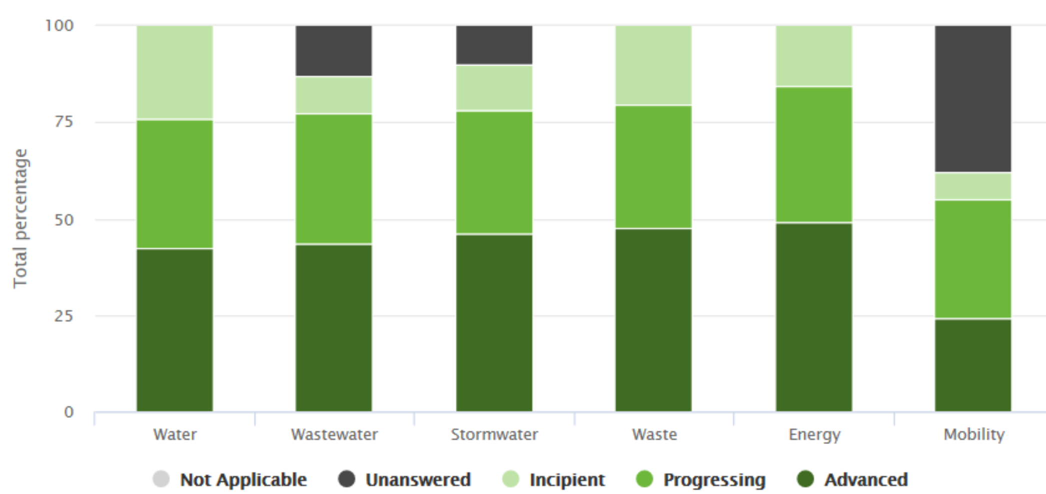
In the Spatial dimension, both objectives Risk Management and Protective Infrastructures and Ecosystems present already around one third of the aspects with advanced development level, while also presenting significant opportunities for improvement.

RAF ASSESSMENT FOR THE FUNCTIONAL AND PHYSICAL RESILIENCE DIMENSIONS

Functional dimension emphasizes each urban service management, autonomy and preparedness for CC. Also, for each urban service, the **Physical dimension** attends infrastructure resilience regarding its safety, autonomy and preparedness for CC. These dimensions also inform about the contribution of each service to Bristol's resilience. The mobility service and the water, energy and mobility infrastructures present generally some shortage in the available information regarding the RAF assessment approach.

DETAILED DEVELOPMENT LEVEL FOR EACH SERVICE – Services contribution to city resilience

FUNCTIONAL

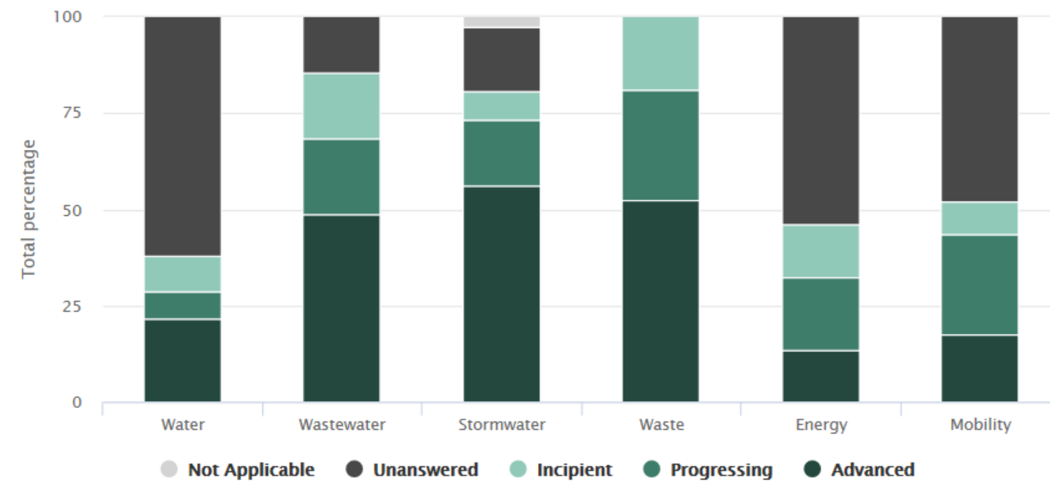


Functional resilience of all services, except the mobility, is advanced in about half of the aspects assessed. It is also evident a relevant progressing development, while presenting significant opportunities for improvement. The mobility service is the one translating significant percentage of metrics that were not answered, may be due to data that is not easily applicable to the metrics provided in the RAF, in some cases, and to lack of information in other cases.

Physical resilience is advanced in about half of the aspects assessed for the water related services, while energy and mobility present a lower percentage of advanced metrics. It is evident the significant progressing development level in all services. This dimension translates the highest percentage of metrics that were not answered, namely regarding the water, energy and mobility services, for the same reasons above mentioned.

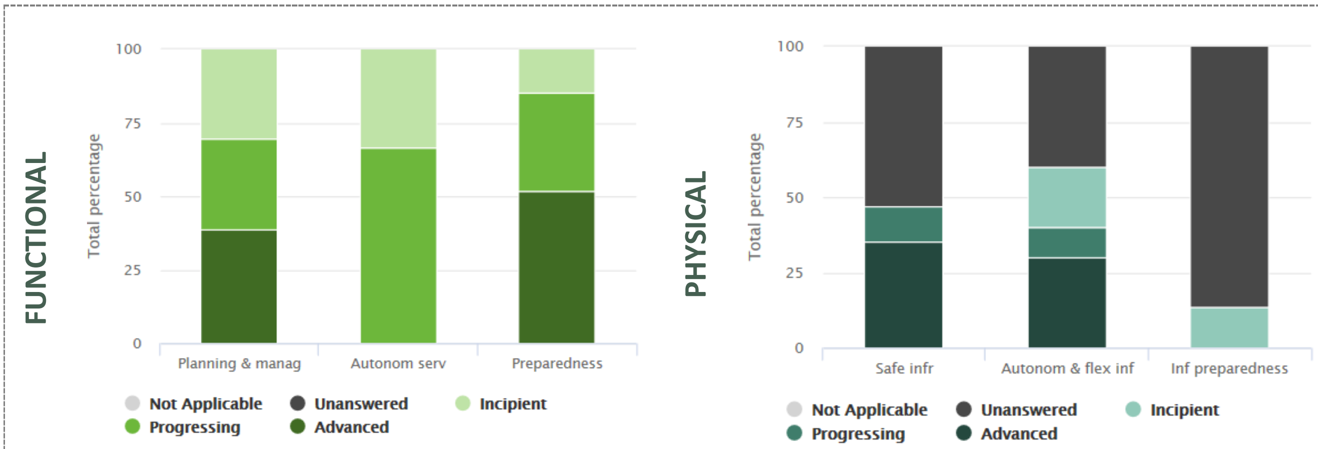
DETAILED DEVELOPMENT LEVEL FOR EACH SERVICE – Services contribution to city resilience

PHYSICAL

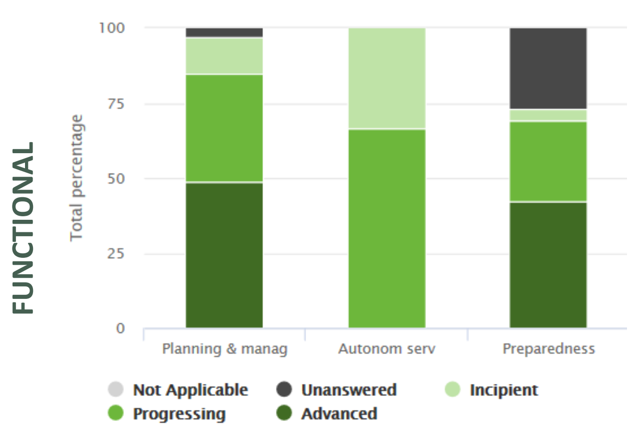


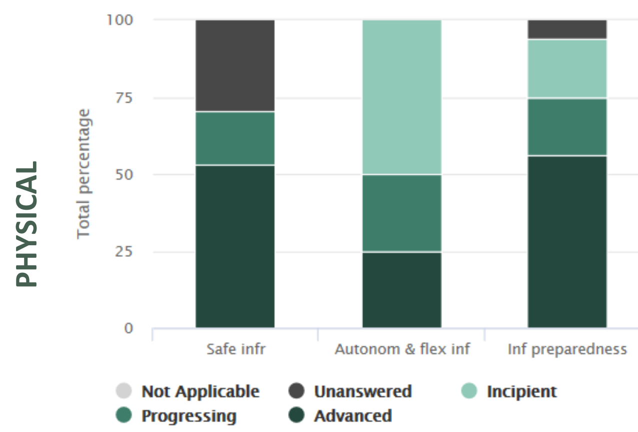
A more detailed assessment for these two dimensions and by service is presented. A more detailed analysis of all dimensions and also by service is described in the SWOT analysis, linking the most advanced objectives to the city main strengths, and the most incipient to the main weaknesses. Other information was also integrated in the SWOT coming from the different assessments carried out as well as from the analysis of context.

WATER

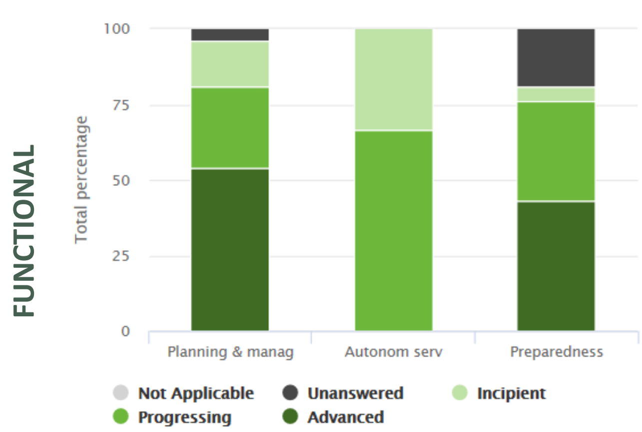


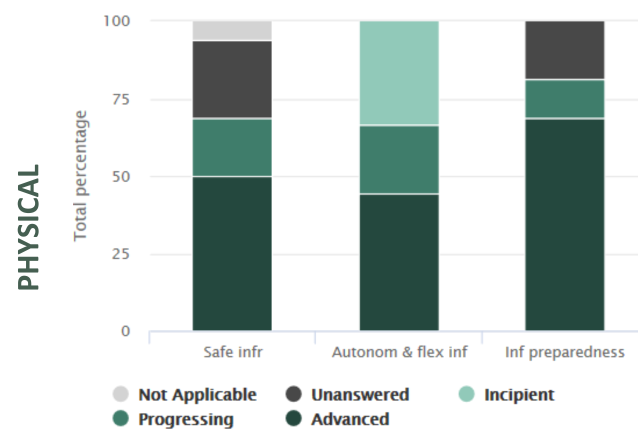
WASTEWATER



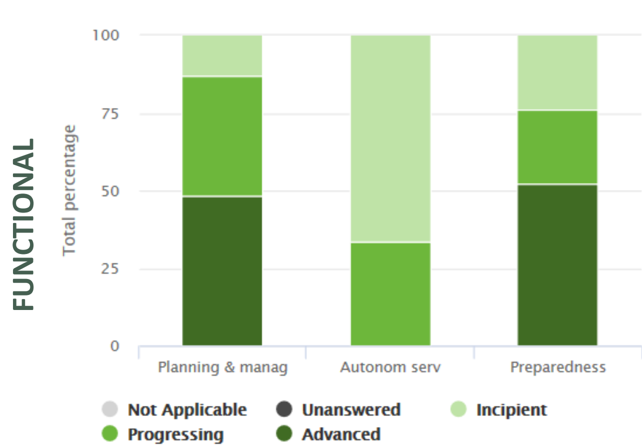


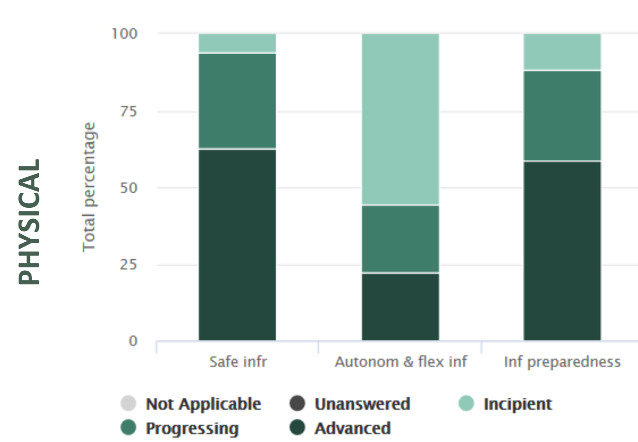
STORMWATER



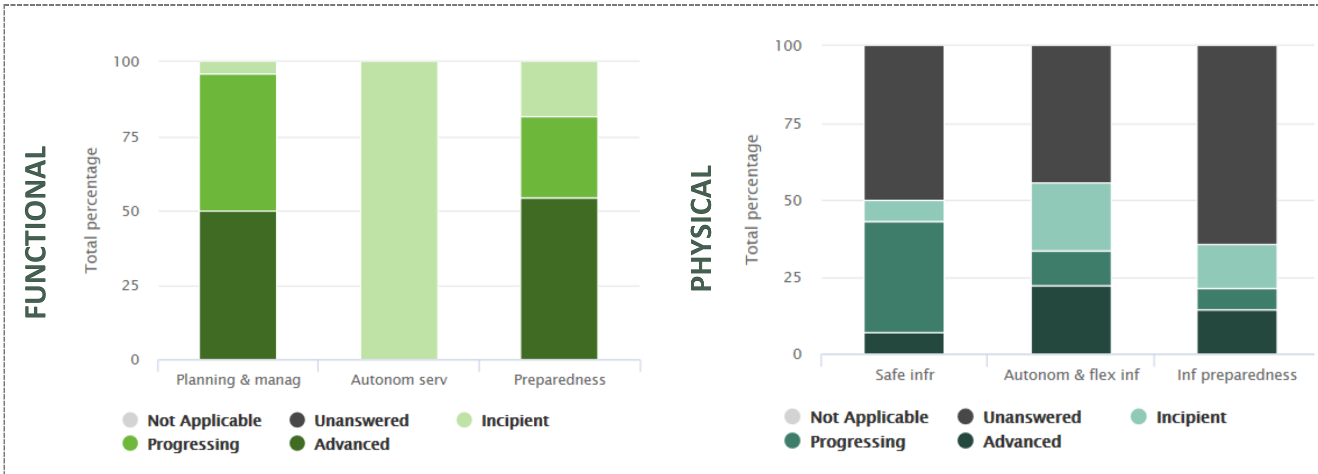


WASTE

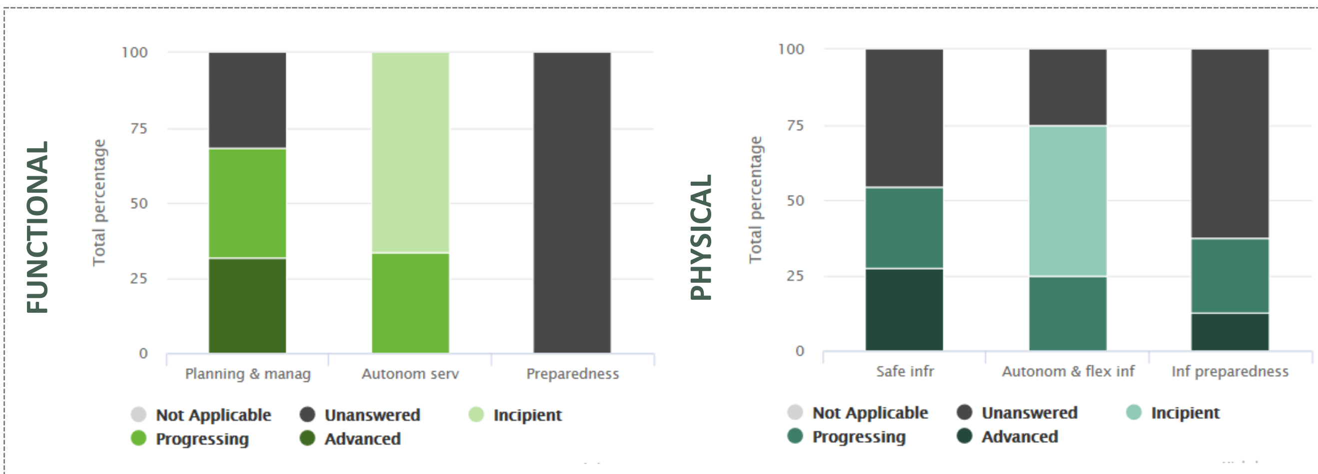




ENERGY



MOBILITY



More complete graphical analysis for each objective, namely by assessment criteria for each urban service, is presented in a confidential annex.

SWOT ANALYSIS

The diagnosis includes the integration of the resilience assessment results provided by all sources of analysis (Russo et al., 2018, Russo et al., 2019, Evans et al., 2018, Evans et al., 2019, Canalias et al., 2017, Pagani et al., 2018, Cardoso et al., 2020a,b). Aligned with the objectives, a SWOT analysis (Strengths, Weakness, Opportunities and Threats) summarizes this information by identifying the city's and the service's internal strengths and weaknesses, as well as the external opportunities and main threats (McClinton, 2015), following the planning process presented before, as proposed in Cardoso et al. (2020a). From a resilience to climate change perspective, a SWOT analysis for Bristol is presented. This SWOT analysis, whenever referring to detailed hazards assessment, applies to pluvial and tidal river flooding. Whenever any of these hazards results in a different assessment, the hazard is specifically mentioned. A more detailed SWOT analysis is presented in a confidential annex.

SWOT ANALYSIS FOR BRISTOL FROM A RESILIENCE TO CLIMATE CHANGE PERSPECTIVE

This SWOT table identifies the aspects related to the city's main strengths and main weaknesses, in the respective columns. Those that are underlined are included in the TOWS analysis that follows.

+ MAIN STRENGHTS	− MAIN WEAKNESSES
- Existing background on resilience - Leadership and management - City preparedness	- Collective engagement and awareness
- Spatial risk management regarding general hazard and exposure mapping	- Spatial risk management regarding hazard and exposure for CC and impacts of climate related events - Dependence and autonomy of protective infrastructures and ecosystems services (regarding other services) considering CC
- Water, wastewater, storm water, waste, energy services planning and risk management - Water, wastewater, storm water, waste, energy services preparedness	- Waste, energy and mobility services autonomy - **Data gaps:** ✓ Wastewater, storm water and mobility services preparedness ✓ Mobility service planning and risk management
- Safe wastewater, storm water and waste infrastructures - Wastewater, storm water and waste infrastructures preparedness - Autonomous and flexible storm water and mobility infrastructures	- **Data gaps:** ✓ Safe water, storm water, energy and mobility infrastructures ✓ Water and energy infrastructures autonomy and flexibility - Wastewater and waste infrastructures autonomy and flexibility - Water, energy and mobility infrastructures preparedness
- Significant historical records of meteorological events	- Expected increased number of flooded electrical substations
- Recently constructed flood defences	
- Identification of high-risk areas and hydraulic deficiencies	
- Significant investments in CSO improvement and strategic sewer projects	
+ OPPORTUNITIES	**− THREATS**
- Coastal area	- Coastal area
- Financial opportunities	- Social cohesion, poor health infrastructure and social and economic inequalities
- National and international recognition and awareness of resilience to CC emergency	- Temperature increase by 2050
	- Heat waves
	- Extreme precipitation increase
	- Sea level rise
	- Wind storms
	- Drought
	- Combined sewer overflows (CSO)

5. RESILIENCE STRATEGIES

IDENTIFICATION OF STRATEGIES

The identification of the strategies that reduce Bristol's threats (**T**), overcome weaknesses (**W**) and exploit strengths (**S**) and opportunities (**O**) was supported by a **TOWS** analysis (Weihrich, 1982), following the planning process presented before, as proposed in Cardoso et al. (2020a). The topics addressed are underlined in the SWOT table to facilitate identification. In this RAP, to address these aspects, the city aims to exploit its strengths and to minimise its weaknesses in order to face the threats, by planning ST and WT strategies to be implemented, mainly targeted for flooding hazard reduction.

TOWS ANALYSIS FOR THE CITY FROM A RESILIENCE TO CLIMATE CHANGE PERSPECTIVE

SO
STRENGHTS/ OPPORTUNITIES

- Not identified for this RAP

ST
STRENGHTS/THREATS

a) Exploit the recently constructed flood defences **to avoid threats** related to the coastal area, namely due to sea level rise.
b) Exploit the existing identification of high-risk areas and hydraulic deficiencies as well as the water infrastructures preparedness, **to overcome threats** related to extreme precipitation increase and CSO.
c) Exploit the identification of high-risk areas and hydraulic deficiencies, strong city leadership and management, and spatial risk management **to overcome threats** related to the extreme precipitation increase and sea level rise.

WO
WEAKNESSES/ OPPORTUNITIES

- Not identified for this RAP

WT
WEAKNESSES/THREATHS

d) Minimise weaknesses regarding collective engagement and awareness **to avoid the impact of threats** related to social cohesion and inequalities.
e) Minimise weaknesses regarding spatial risk management regarding hazard and exposure, namely to CC and impacts of climate related events, **to avoid the impact of coastal area threats**.
f) Minimise the expected increased number of flooded electrical substations **to avoid the impact of extreme precipitation increase and CSO**.
g) Minimise the expected increase number of flooded electrical substations and need of enhancing energy and mobility infrastructure preparedness **to avoid the impact of threats** related to the extreme precipitation increase and sea level rise.

As **ST** strategies that exploit strengths to avoid threats (a, b and c in the previous table), the city identified respectively "**Build riverside flood defence walls"**, "**Adding rain gardens before sewer inlet points"** and "**Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis".**

As **WT** strategies that minimise weaknesses and avoid threats (d, e, f and g in the previous table), the city considered respectively **"Develop community flood plans", "Build riverside flood defence walls"**, **"Adding rain gardens before sewer inlet points"** and **"Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis"**.

Some challenges identified in the SWOT are still to be addressed in the future, namely some threats (poor health infrastructure and economic inequalities, wind and temperature increase related events) and weaknesses (related to data gaps, to some services and infrastructure autonomy and preparedness). Also, strategies that take advantage of Bristol's opportunities were not identified for this RAP.

STRATEGIES TO IMPLEMENT

DESCRIPTION

The strategies to implement are further detailed in the following tables, supported by information from Martínez-Gomariz et al. (2017) and Martínez-Gomariz et al. (2019).

1 – Develop community flood plans

DESCRIPTION

Empowering communities to take action themselves in preparation for and during and after a flood event enhances personal resilience.

Reliance on emergency services and responders can only span so far to a large population. Raising awareness and promoting self-motivated actions helps reduce this reliance.

Typology: Citizens and stakeholders

TOWS perspective: WT

	O	T
S	SO	ST
W	WO	**WT**

Implementation: Planned

Timeline: 2020-2023

Hazard: Flooding

Variables: Intense precipitation, sea level rise

Institution: Bristol City Council

Players: BCC Flood Risk Management team

Services:

Civil Protection Unit — Highways — Mobility — Waste

Costs:

Short-term: staff time — Mid-term: staff time

MEASURES:

M009FLOOD	Develop community flood plans

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
Cost savings Increased property values	**Reduced mortality impacts** **Reduced health impacts** **Reduced mortality from diseases** **Enhanced public amenity** **Reduced impacts on vulnerable groups** **Reduced number of householders, businesses forced from homes, places of work** **Social inclusion**	Reduced water pollution **Reduced land contamination** Improved biodiversity and ecosystems **Maintained and increased green space** **Reduced environmental impacts through associated awareness** Increased biodiversity and ecosystem services

Other resources	Environment Agency
Relevant info.	Community engagement strategies

2 – Build riverside flood defence walls

DESCRIPTION

Increase the height of existing defences or build new walls in places to future design flood levels inclusive of climate change predictions.

Rising sea level and high tides further encroaching on riverside land.

Typology: Protective infrastructures	**TOWS perspective:** ST, WT
Implementation: Planned	**Timeline:** 2020 - 2025 approvals and design 2025 onwards construction
Hazard: Flooding	**Variables:** Sea level rise
Institution: Bristol City Council	**Players:** BCC Flood Risk Management team and Environment Agency

Services:

Multiple

Costs:

Short-term: > 1.000.000 €   Mid-term: > 1.000.000 €

MEASURES:

M001SLRISE Build riverside flood defence walls

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
Cost savings	**Reduced mortality impacts**	Improved water quantity
Reduced energy losses	**Reduced health impacts**	Reduced aquifer depletion
Job creation	**Reduced mortality from diseases**	**Reduced water pollution**
Possible reduction in prices	**Enhanced public amenity**	**Reduced land contamination**
Increased labour productivity	**Reduced impacts on vulnerable groups**	Improved biodiversity and ecosystems
Increased economic production	**Reduced number of householders, businesses forced from homes, places of work**	**Maintained and increased green space**
Increased property values	**Social inclusion**	Reduced environmental impacts through associated awareness
		Increased biodiversity and ecosystem services
		Effective/uninterrupted water collection and security
		Erosion control

Other resources	Consultants
Relevant info.	River Avon project team fed RESCCUE analysis

3 – Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis

DESCRIPTION

Tidal, fluvial and rainfall computer simulation and analysis of extreme flood events helps identify potential problematic areas.

Realising where flood prone areas could be may not be apparent unless there has been an extreme flood of that nature experienced in the past. This helps to figure that out and quantify the impacts.

Typology: Modelling studies

TOWS perspective: ST, WT

Implementation: Implemented / Planned continuous updating

Timeline: Ongoing

Hazard: Flooding

Variables: Intense precipitation, Sea level rise

Institution: Bristol City Council

Players: BCC Flood Risk Management team

Services:

Urban drainage – wastewater and stormwater
Tidal river influences and flood defence operation

Costs:

Short-term: 5.000 – 25.000€ Mid-term: 5.000 – 25.000€

MEASURES:

M008FLOOD	Identify high risk areas by conducting studies involving flood modelling analysis

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
Cost savings	Reduced mortality impacts	Reduced water pollution
Job creation	Reduced health impacts	Reduced land contamination
Possible reduction in prices	Reduced mortality from diseases	Improved biodiversity and ecosystems
Increased labour productivity	Enhanced public amenity	Maintained and increased green space
Increased economic production	**Reduced impacts on vulnerable groups**	Reduced environmental impacts through associated awareness
Increased property values	**Reduced number of householders, businesses forced from homes, places of work**	Increased biodiversity and ecosystem services
	Social inclusion	

Other resources	Flood modeller consultancies
Relevant info.	Additional information on risk assessment impacts may be visualised in https://csis.myclimateservice.eu/studies

4 – Adding rain gardens before sewer inlet points

DESCRIPTION

An additional point of connection from the roof drainage rainwater down pipe. Removing the first few millimetres of rain before discharging to the sewage network via an overflow system.

Addresses surface water runoff and sewer overload.

Typology: NBS and ecosystems services

TOWS perspective: ST, WT

Implementation: Planned

Timeline: 2020 - 2025

Hazard: Flooding

Variables: Intense precipitation

Institution: Bristol City Council

Players: BCC Flood Risk Management team

Services:

Mobility

Costs:

Short-term: - € Mid-term: - €

MEASURES:

M011FLOOD Adding rain gardens before sewer inlet points

CO-BENEFITS: Relevant contribution | Slight contribution

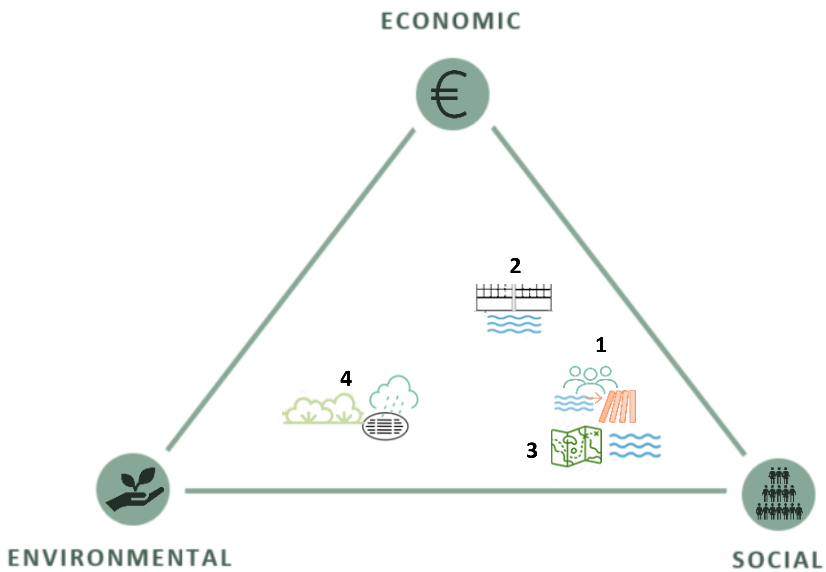
ECONOMIC	SOCIAL	ENVIRONMENTAL
Cost savings	Reduced health impacts	Improved air quality
Reduced energy losses	**Enhanced public amenity**	Improved water quantity
Increased labour productivity	Social inclusion	**Reduced water pollution**
Increased economic production		**Reduced land contamination**
Increased property values		**Improved biodiversity and ecosystems**
		Maintained and increased green space
		Reduced environmental impacts through associated awareness
		Increased biodiversity and ecosystem services
		Effective/uninterrupted water collection and security

Other resources	Traffic management schemes
Relevant info.	SuDS Manual, ASA

CO-BENEFITS AND IMPACT ON RESILIENCE OBJECTIVES

CO-BENEFITS OF IDENTIFIED STRATEGIES

The identified strategies have several co-benefits, namely within the economic, social and environmental components. Within each component, the expected co-benefits contribute differently in each strategy. Depending on the relative contributions, the location of the strategy in the scheme below varies.



Strategy 1 – "Develop community flood plans" is more related to the social co-benefits and it also contributes to some environmental aspects. Strategy 2 – "Build riverside flood defence walls" is quite balanced regarding the three components. It is more related to the social co-benefits and also highly related to the economic co-benefits, the environmental co-benefits have less relative relevance. Strategy 3 – "Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis" is essentially related to the social co-benefits, and Strategy 4 – "Adding rain gardens before sewer inlet points" is more related to the environmental co-benefits.

IMPACT OF IDENTIFIED STRATEGIES ON EACH RESILIENCE DIMENSION

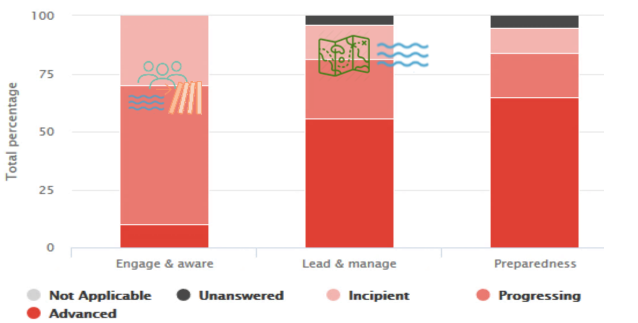
The impact of the identified strategies on the RAF resilience objectives for Bristol is highly significant. The identified strategies address all the resilience dimensions as well as all services considered in this RAP.

IMPACT OF IDENTIFIED STRATEGIES ON THE CITY'S RESILIENCE OBJECTIVES, FOR EACH RESILIENCE DIMENSION

STRATEGIES	
1. DEVELOP COMMUNITY FLOOD PLANS	2. BUILD RIVERSIDE FLOOD DEFENCE WALLS
3. UPDATE HIGH-RISK AREAS BY FLOOD MODELLING ANALYSIS	4. RAIN GARDENS BEFORE SEWER INLET POINTS

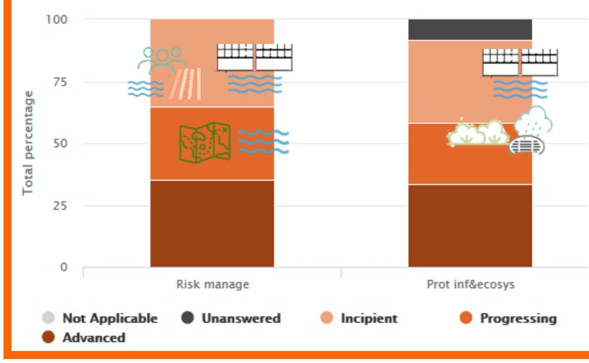
ORGANISATIONAL

COLLECTIVE ENGAGEMENT & AWARENESS | LEADERSHIP & MANAGEMENT | CITY PREPAREDNESS

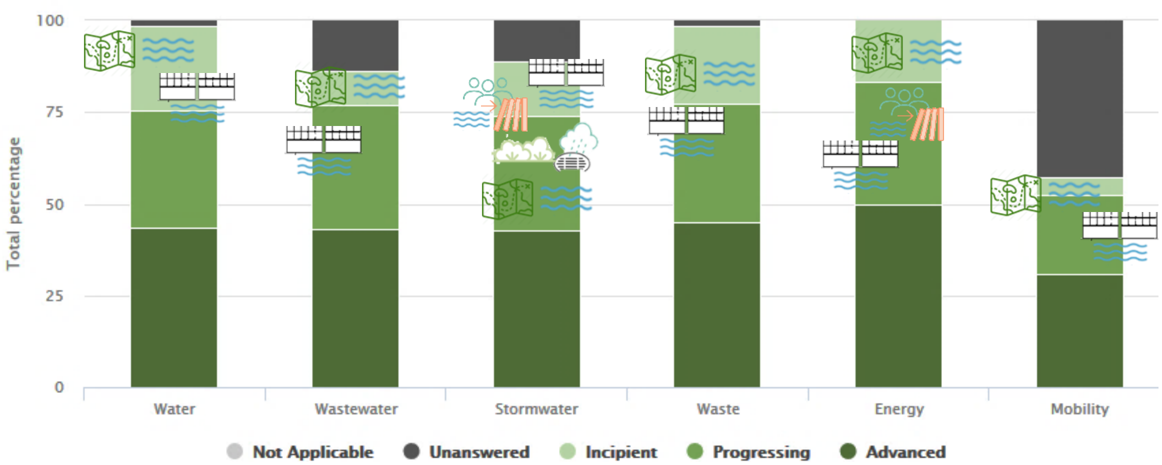


SPATIAL

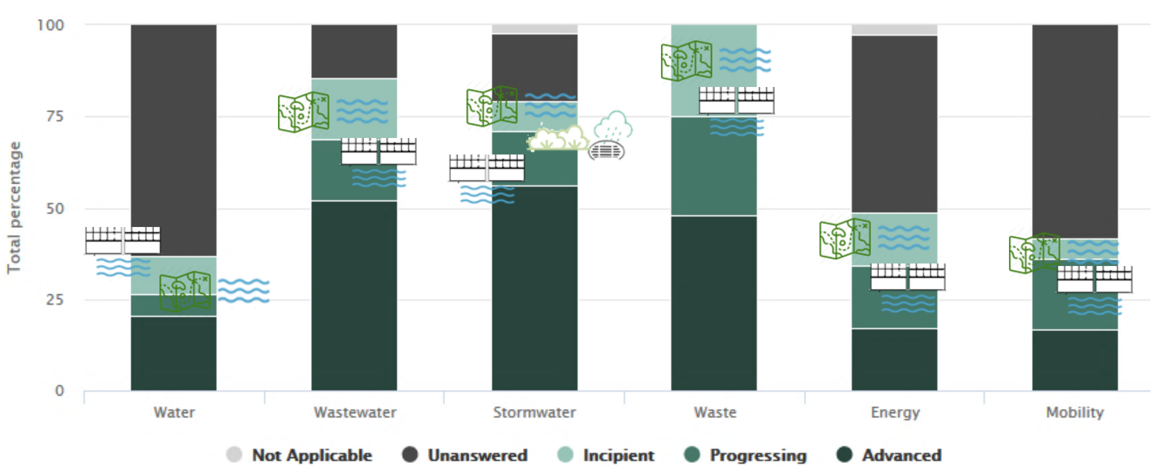
SPATIAL RISK MANAGEMENT | PROTECTIVE INFRA. & ECOSYSTEMS



FUNCTIONAL

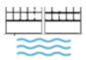


PHYSICAL



DEVELOP COMMUNITY FLOOD PLANS

Strategy 1 - "Develop community flood plans" will contribute to improve organisational resilience, namely regarding the collective engagement and awareness objective, as well as spatial resilience, regarding the spatial risk management objective. This strategy is also related to functional resilience of stormwater and energy services.



BUILD RIVERSIDE FLOOD DEFENCE WALLS

Strategy 2 - "Build riverside flood defence walls" will contribute to both objectives of spatial resilience, and it is related to functional and physical dimensions of all services.

UPDATE HIGH-RISK AREAS BY FLOOD MODELLING ANALYSIS

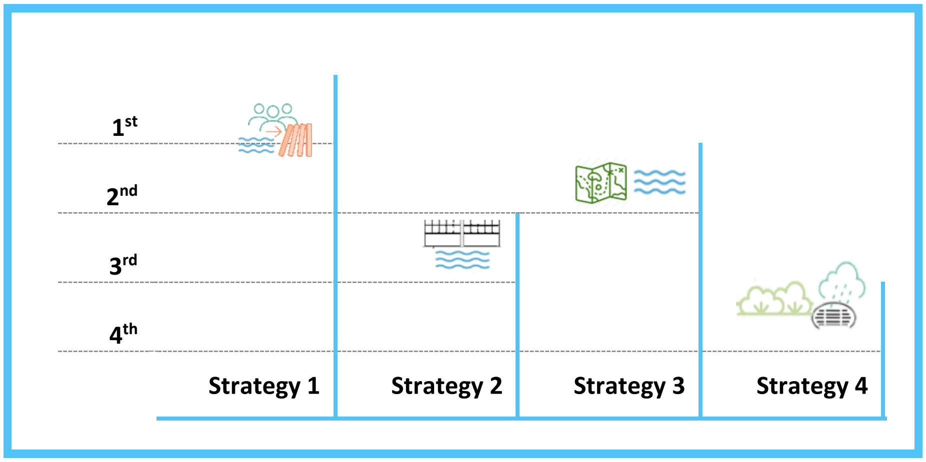
Strategy 3 - "Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis" will contribute to improve organisational resilience, namely regarding the leadership and management objective, and spatial resilience, regarding the spatial risk management objective and it is related to functional and physical dimensions of all services.

RAIN GARDENS BEFORE SEWER INLET POINTS

Strategy 4 - "Adding rain gardens before sewer inlet points" will contribute to spatial resilience regarding the protective infrastructures and ecosystems objective, and to functional and physical dimensions of the stormwater service.

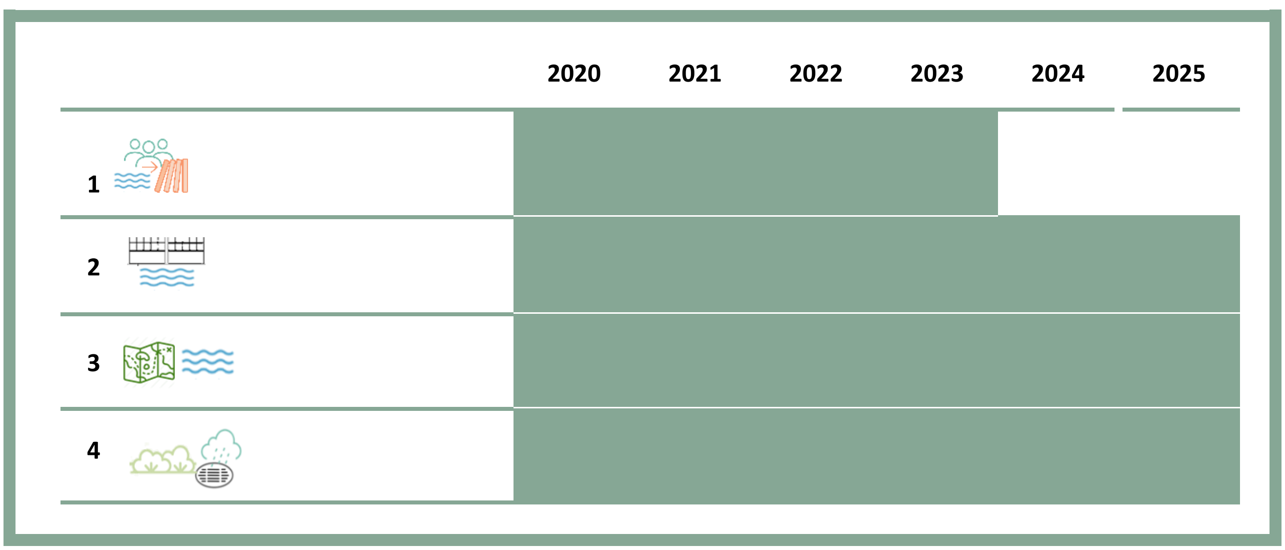
PRIORITIZATION

Prioritization of strategies is mandatory whenever resources are limited or when different strategies compete for the same resources. Bristol is committed to implement the strategies "Develop community flood plans", "Build riverside flood defence walls", "Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis" and "Adding rain gardens before sewer inlet points". Strategies considered for prioritization are developing community flood plans and following the identification of high-risk areas by conducting studies involving flood-modelling analysis an Ashton flood relief strategy to be researched. This was following the method identified in the planning process that includes the application of Cost-Effectiveness Analysis (CEA) and ranking of the co-benefits for given sets of measures. These inputs were provided by the RESCCUE web-based platform for strategies and measures. The next step was a Cost-Benefit Analysis (CBA). The social oriented strategies (Develop community flood plans) were ranked using a Multi-Criteria Analysis (MCA), as it emphasises the judgement of the decision-making team and has the ability to prioritize without the provision of monetary values (Evans et al., 2020).



Based on the results, Bristol considered to firstly implement the "Develop community flood plans" strategy, followed by "Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis", "Build riverside flood defence walls" and then by the "Adding rain gardens before sewer inlet points" strategy.

IMPLEMENTATION PLAN



6. RAP MONITORING AND REVIEW PROCESS

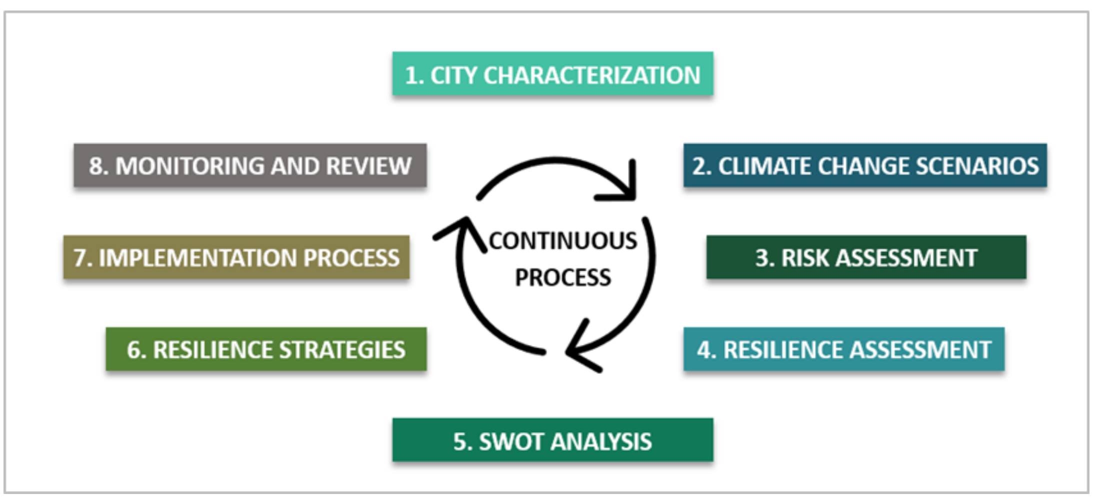
MONITORING

In order to trace the progress of the resilience strategies implementation, of resilience changes and to identify early deviations that may require corrective action, the RAP monitoring is planned as follows.

Periodicity	Yearly
Responsibility	John Stevens, BCC
Activities	Trace strategies implementation
	Acknowledge resilience improvements or setbacks
	Identify unexpected facts with impact on resilience

REVIEW

To continuously ensure the city resilience considering the city's dynamics, the RAP review is a crucial step. In this plan some of the challenges identified in the SWOT are still to be addressed in the future, namely a few threats (poor health infrastructure and economic inequalities, temperature increase related events and wind storms) and weaknesses (related to data gaps, dependence and autonomy of protective infrastructures and ecosystems services, as well as waste, energy and mobility services autonomy). Also, strategies that take advantage of Bristol's opportunities were not identified in this RAP.



Periodicity	Yearly
Responsibility	John Stevens, BCC
Activities	Analyse monitoring results
	Re-think SWOT
	Re-think TOWS
	Re-think previously identified and postponed strategies
	Evaluate updated knowledge on climate change

7. FINAL REMARKS

MAIN BENEFITS AND FUTURE CHALLENGES

BENEFITS	FUTURE CHALLENGES
• Current situation evaluation and Baseline setting. • Definition of multisectoral goals, indicators and targets. • City resilience monitoring based on climatic scenarios. • Increase of Bristol stakeholders involvement for strategies implementation • Informed analysis to prioritise and target limited resources	• Implement the strategies according to the plan • Address new data and information • Include other hazards • Monitor and review the plan • Financial backing and resources from constrained budgets • Engagement from crucial stakeholders

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OTHER SOURCES

Clarity portal, https://csis.myclimateservice.eu/studies

RESCCUE project, www.resccue.eu

RESCCUE tool kit, www.toolkit.resccue.eu

BRISTOL RESILIENCE ACTION PLAN - 2020-2025

Bristol City Council

July 2020

RESCCUE

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

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